Test Procedure for Proton Displacement Radiation Testing of Piece-Parts

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1.0 SCOPE

This procedure covers displacement damage radiation testing of piece-parts. The requirements are given herein for the test procedure and sequence; in addition, parts handling and data recording are also defined.

2.0 DEFINITIONS

Definitions of terms used in this procedure are given in this section:

Device or Piece-Part - A single item of a given part type.

Control Unit - A device from the lot to be tested that is not subjected to the radiation environment. The function of this device is to verify the integrity of the measurement data.

Fluence - Total number of protons per cm^2.

Flux – Rate of particle delivery in particles/cm^2/sec.

3.0 TEST DOCUMENTATION

3.1 Radiation Test Traveler and Sign Off Sheet (Traveler)

A Radiation Test Traveler and Sign Off Sheet (Figure 1) will accompany each group of devices of the same type and/or lot which are to be tested at one time. The purpose of the traveler is to completely identify the parts and assure compliance in each major procedure step.

3.2 Radiation Test Log

Each lot of piece-parts to be tested is logged in and assigned a unique log number for later tracking. Each device will be given a unique serial number so that data can be referenced to a specific part.

4.0 TEST SAMPLES

Test samples are either evaluation samples or samples taken a flight lot. All device types are to be treated as "charge sensitive", requiring special handling to protect against static electrical discharge. At least five test samples and one Control Unit are recommended for each test.

Electrical tests before irradiation will verify that the test samples are within customer specifications. A device out of applicable specification limits will be tested only after the discrepancy has been resolved with the customer.

5.0 FACILITIES AND DOSIMETRY

Four different facilities are used for proton testing: (1) University of California, Davis cyclotron, (2) University of Indiana cyclotron, (3) Loma Linda University synchrotron, and (4) the Harvard University cyclotron. The choice of facility is dependent on facility availability and proton energy specified.

5.1 Beam Area and Calibration

All four facilities produce proton beams with diameters of 3 to 10 cm. The first step in using them is to calibrate the proton flux and energy. The four facilities perform this calibration using established methods tailored to their particular beam handling and diagnostic methods. They provide an initial calibration as well as records of the operating current and energy of each individual experimental run. They additionally provide information about beam uniformity within the area specified for their facility. Facility operators control the beam and run time for each run in response to user specifications.

5.2 Typical Irradiation Procedure

After initial calibration the devices to be irradiated are placed on a test fixture that is located at the previously calibrated distance from the beam exit port. After the devices are placed in the irradiation position, bias conditions are applied, the devices checked for proper operation and the experimenters leave the irradiation area. The facility operators then irradiate the experiment to the desired fluence level. The experimenters reenter the irradiation area and remove the devices for testing with other equipment located in a "Customer Laboratory" supplied by the facility. After measurements the devices are returned to the irradiation area for subsequent irradiations.

5.3 Test Board Activation

When proton energies above 5 MeV are used the parts become radioactive. The degree of radioactivity depends on fluence, energy and material present in the device package and test board (gold and solder are particularly easy to activate). The activation is a personnel hazard that must be taken into account when tests are planned and executed. All facilities provide radiation monitors and individual dosimeters to insure that the amount of radiation is within acceptable health limits, as required and defined by the Nuclear Regulatory Commission.

Because of this activation it may be necessary for the activated parts to remain at the test facility for several weeks to allow the activity to diminish to a safe level, after which there can be returned to the experimenter.

6.0 TEST EQUIPMENT

Electrical test equipment, including power supplies, digital voltmeters, microammeters, etc., are used in carrying out the tests required on the test requirements. The test equipment list may change from test to test due to differences in measurement requirements. Calibration of applicable test equipment will be done on a routine basis.

7.0 CONTROL UNITS

A device from each test lot will be used as a Control Unit. The Control Unit will be measured before each set of post-irradiation parametric measurements, but not exposed to the radiation. The purpose of the Control Unit is to verify the stability of the measuring equipment.

8.0 TEST PROCEDURE

This test procedure is a general plan and it is anticipated that minor deviations will occasionally be necessary.

8.1 Radiation Test Requirements

Electrical parameter tests, proton energy, fluence and flux levels will be agreed to between radiation test personnel and the customer prior to initiation of testing.

8.2 Test Fixtures and Equipment

The test setup will be assembled, the necessary test equipment obtained and checked out to insure proper operation to minimize the possibility of damaging test parts. After suitability of the test setup has been established, the test device electrical parameters will measured on the radiation test system in the laboratory. For transistors, start measurements at the lowest current operation levels to obtain comparable measurements.

8.3 Research Testing

Research testing by its very nature prohibits following predetermined rigid test requirements such as specified herein. For example, requirements are revised during and after testing, standard data reduction methods may not be appropriate and personnel other than the Test Engineers may be involved.Although deviations from this document may be required for research testing, the requirements of this test procedure will be followed as

closely as practicable.

9.0 DATA REQUIREMENTS

It is extremely important that all numbers that can be determined from the device package and accompanying paper work be recorded on the data sheets to fully identify each device tested.

The minimum data to be recorded will be:

1. Proton energy
2. Flux
3. Fluence
4. Device response.

RADIATION TEST TRAVELER AND SIGN-OFF SHEET

Device Type: _____Test ID No: _____ S/Ns: _____
Mfr.: _____ Log-in Date: _____
Pkg. Type: _____
Lot No: _____ Lot Accept. (check) _____ Other ID Nos.: _____
Wafer No.: _____ Test Type: _____
Date Code: _____ Quantity: _____

Tester Type: _____ Control Unit Type: _____
Tester Name: _____ Control Unit No: _____
Other Controls: _____

Sign Off List for Requirements and Test Steps	Initial	Date
1) Parts received for testing and logged in		
2) New/revised radiation test requirements developed or old requirements verified		
3) Bias circuit built and checked		
4) Coordinate Test Data Formatting and Handling		
5) Bias Circuit Designed and Checked		
6) Test carried out per requirements		
7) PIE measurements taken per requirements (if applicable)		
8) Parts returned to storage and test data to JPL		

Comments:

Figure 1
Radiation Traveler and Sign-off Sheet